we are discussing. This second investigation is in complete accordance with the first.

"We may then hope that astronomers will accept with confidence the work which we now place before them. It is our intention to print elsewhere all the details necessary to enable any person to verify the parts which he may be interested in examining more closely. In this manner, should a doubt arise on any point, it will easily be seen in what direction the work of verification should be directed.

"The two succeeding sections comprise the theories of the perturbations of *Jupiter* by *Uranus* and *Neptune*.

"The fourth contains the perturbations of *Saturn* by *Uranus* and *Neptune*.

"Then follow three sections, containing the perturbations of *Uranus* by *Jupiter*, *Saturn*, and *Neptune*. The investigation of the perturbations of *Uranus* by *Saturn* was made many years ago, but I then followed the method of interpolation. In the present work, in which the results agree with the former one, I have adopted the algebraic form, which can be applied to any epoch.

"The last sections contain the perturbations of *Neptune*, produced by *Jupiter*, *Saturn*, and *Uranus*.

"To bring this work to a satisfactory conclusion, it will be necessary,—

"1. To calculate the formulæ, and to reduce them into the form of provisional tables.

"2. To combine all the accurate observations of the four planets, and to re-discuss them in order to refer their positions to the same system of co-ordinates.

"3. By means of the provisional tables to calculate the apparent places of the planets for the epochs of the observations.

"4. To compare the observed with the tabular places; to deduce the corrections of the elliptic elements of the four planets, and to determine if the agreement is then perfect.

"5. Should the agreement not be satisfactory, to investigate the cause of the discordance."

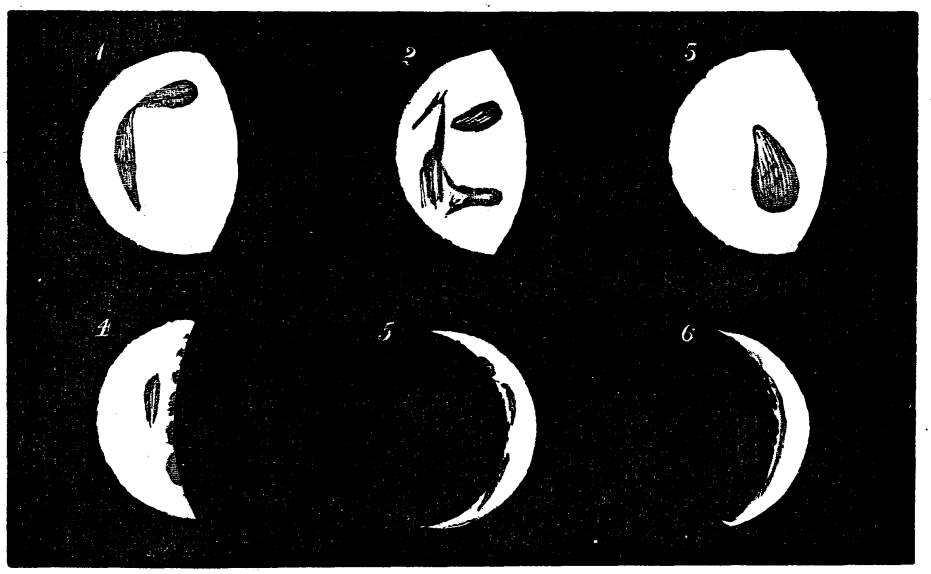
Observations of the Planet Venus, with a 6·inch Silvered Glass Reflector. By R. Langdon, Esq.

(*Communicated by J. Norman Lockyer, F.R.S.*)

On May 1st, 1871, I had a good view of the planet *Venus;* but I could not at first see her to my satisfaction as her light was so bright. She had more the appearance of a miniature sun than a star; but I put a diaphragm of blackened card in the eye-piece, and made a small hole through its centre with a piece of hot wire. I found this arrangement keep out to a great extent the glaring rays. I also sometimes used a slip of slightly-tinted glass in

front of the eye lens; this enabled me to bring the planet entirely under subjection. Her shape was that of the Moon when a little more than half full. I distinctly saw a dull, cloudy-looking mark along her bright limb, curving round parallel to it, extending nearly across the disc, each end terminating in a point; joining this at the eastern extremity, was another and darker mark of a club shape, its small end joining the point of the mark previously described. (See Sketch No. 1.) I watched these marks for half-an-hour; I saw some marks again the next evening, but before I could examine them the planet was hid behind some clouds.

On May 6th, at 7.45 P.M., there was a cloud-like mark extending straight across the disc, and a club-shaped mark nearly in the centre, with its small end nearly touching the straight cloud. On the western limb another dark mark had made its appearance; it was not quite so large as the other, and it was not club-shaped; but its sides were parallel to each other till they approached the



straight cloud, when they appeared to divide, each side curving round away from the other. (See Sketch No. 2.)

I took much interest in watching these spots, as I had read that "it was very doubtful whether any marks had ever been seen on this planet." I called several men to look at them, and they were able to describe them, although they had no previous knowledge or idea of what they were likely to see. One man was very confident it was the Moon he was looking at, but when I pointed out to him the Moon was not in the neighbourhood, he said he thought it was the Moon, because he could plainly see the dark patches on its surface.

On May 13th, at 7.30 P.M., there was a dark mark of a pear shape, extending from near the western edge to two-thirds the distance across the bright disc. This mark was not so dark as

those seen on the 1st and 6th, but it was much larger. (See Sketch No. 3.)

On July 28th, at 8 P.M., there were visible five dusky marks along the planet's terminator, and one nearly in the centre of the crescent; but they were not so well defined as those before described; but what seemed to me more remarkable, was that the southern horn was rounded off considerably, whilst the northern horn was quite sharp, and ran out to a very fine thread-like point. (See Sketch No. 4.)

On October 13th, at 5.45 A.M., I saw *Venus* as a beautiful little crescent. She was well defined, and both horns were as sharp as the finest-pointed needles. I think I detected a dusky cloud-like mark about half way from the centre to the northern horn; but I am not quite sure about this, as I had to leave the telescope before I could complete my sketch. (See Sketch No. 5.)

On October 25th, at 8.10 A.M. On this occasion I was gratified with a sight which I had waited for and longed to see for many years; that was to have a good view of *Venus* by daylight. I now had the longed-for opportunity, and it turned out as I expected it would—that the superior light of the Sun would overcome that of the planet to such an extent as would enable me to see her better than I had ever seen her before. I could now plainly perceive the jagged nature of the terminator, the unevenness of which could not be mistaken; but what was very remarkable, the northern horn was bent in towards the centre of the planet; it appeared as if a notch had been cut in the inside, and a slice cut off from the outside. (See Sketch No. 6.)

I have no idea what was the cause of this appearance; I have never seen it so before, neither do I recollect ever having read of such a phenomenon. I did not perceive any markings on this occasion, but there was a kind of haziness along the whole length of the terminator; but I considered this at the time to have belonged to the terminator rather than to any markings on the disc. The terminator on this occasion was inky black.

November 9th, I saw *Venus* every half-hour during the day up to 1 o'clock. I made a sketch at 12.20 P.M. I could now distinctly see the jagged terminator, the nature of which was so much like that of the Moon as it was possible to conceive, except that if we compare the Moon's terminator to a piece of network, that of *Venus* would be represented by a piece of fine lace. I could also see some thin, cloudy marks on her disc. The southern horn was very sharp; the northern one was a trifle rounded.

I saw *Venus* on February 5th, 1870 (a few days before her inferior conjunction with the Sun), the bright part was an exceedingly beautiful fine crescent; but myself and several other people could see the whole body of the planet in the same manner as we see the dark limb of the Moon when *Earth-shine* is falling upon it; but I did not make any sketch at the time.

I have observed *Venus* a great many times besides those mentioned above, having made it my special work to do so, and

have on several occasions strongly suspected markings to have been visible; but I have not mentioned them, and have only described those times upon which I have had no doubt of what I had seen.

Silverton Station, near Cullompton, Devon.

New Tables of Uranus. By Simon Newcomb.

(*Extract from a Letter addressed to the Astronomer Royal.*)

"When I last enjoyed the pleasure of writing to you, I made known that I had long been engaged in perfecting the theory and tables of *Uranus*. After devoting a large amount of labour to this subject during the last twelve years, the work is now, I hope, approaching its close. I have fixed upon the opposition of 1871–2, as the last one on the observations of which the tables are to be founded.

"I now write to inquire whether you will kindly communicate to me the results of the Greenwich Observations of *Uranus* during the years 1870, 1871, and 1872, to be used in the final equations of condition.

"So far as I have yet compared my final provisional theory with observations, the indications are, that the motion of the planet during the ninety years since its discovery, will be represented within a small fraction of a second of arc, and, in consequence, that no evidence will be found to indicate the action of a trans-Neptunian planet. On this point, however, I cannot yet speak positively. So far as I know, the planet *Neptune* has not yet deviated sensibly from my tables. With the comparison of the Greenwich Observations for 1871 with the *Nautical Almanac*, you are better informed on this point than I am.

"Permit me to congratulate you on setting at rest the question whether the thickness of the objective has any influence on aberration. There could be little doubt of the result after Hoek's experiments; but it is always more satisfactory to test a theory by a crucial experiment—*a posteriori*."

Washington, May 16th, 1872.

Discovery of Minor Planet (121). By Mr. Watson.

(*Extract from a Letter addressed to the Astronomer Royal.*)

I have the pleasure to send you the following observations of a new planet which I have discovered:—

Ann Arbor M.T.		R.A.	Decl.	No. of Comparisons.
	h m s	h m s	° ′ ″	
1872 May 12	12 5 0	16 20 41·20	−18 53 6	1
12	14 13 22	16 20 37·58	−18 53 9·4	5
13	11 13 22	16 19 59·33	−18 52 46·1	6

It shines like a star of the 11th magnitude.

Ann Arbor, May 14, 1872.